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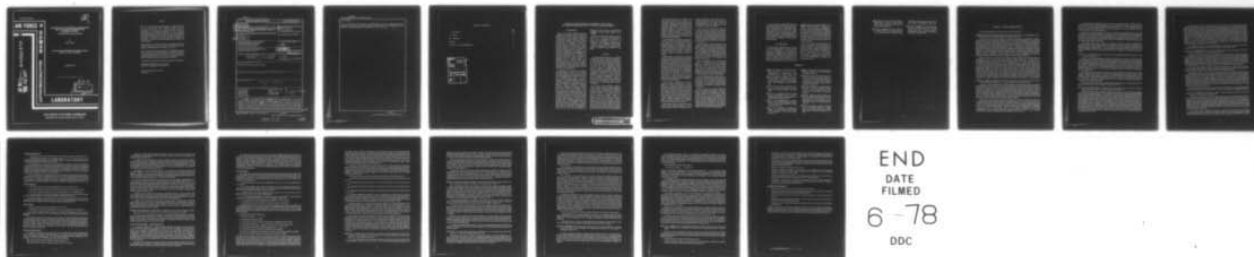
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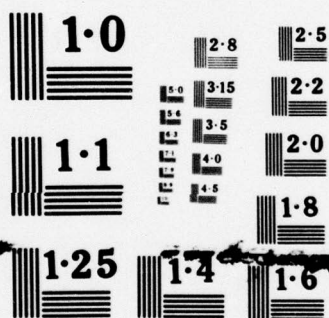
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**INFLUENCE OF THE EXTERNAL LABOR MARKET
ON THE AIR FORCE MANPOWER AND
PERSONNEL SYSTEM:
A REVIEW OF SELECTED RESEARCH**

By
John N. Taylor

**OCCUPATION AND MANPOWER RESEARCH DIVISION
Brooks Air Force Base, Texas 78235**

December 1977

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| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This technical report documents a review of selected studies undertaken to determine if a theoretical framework has been developed which reveals how economic factors transmit their effects into the Air Force Manpower and Personnel System (AFM&PS). This report also determines if a consistent rationale has been developed to serve as a basis for formulating Air Force policies which optimally respond to environmental fluctuations. Studies were examined that describe quantitative relationships between the external labor market (ELM) and the AFM&PS. Of particular interest were studies directed toward determining whether definite relationships could be established that link the ELM with (a) career and training preferences of present and potential members of the Air Force, (b) retention rates by job and/or skill categories of current Air Force members, and (c) | | |

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structural characteristics and internal behavior of the AFM&PS. Results of this study, if applicable, will be used in developing an ELM module for the Integrated Simulation Evaluation Model of the AFM&PS. Contained in the appendix is an annotated bibliography of the technical reports reviewed for this study.

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INFLUENCE OF THE EXTERNAL LABOR MARKET ON THE AIR FORCE MANPOWER AND PERSONNEL SYSTEM: A REVIEW OF SELECTED RESEARCH

I. INTRODUCTION

The Air Force Human Resources Laboratory (AFHRL) is conducting a program of research and development to provide Air Force policy and decision makers with the capability to simulate, in a timely and consistent manner, the response characteristics of the Air Force Manpower and Personnel System (AFM&PS) as it adjusts to environmental and internal policy changes. Subsequent analysis of the system response characteristics would be a basis for assessing the effectiveness, adaptability and efficiency of the complex of administration and training structures that govern the operation of the AFM&PS. It has long been recognized that one of the key sets of environmental factors (which constrains the freedom of action of decision makers in the AFM&PS) is the set comprised of what is sometimes loosely referred to as "economic variables." These variables directly interact with the supply of qualified military input available and the demand for separation by personnel that exists at any time in the Air Force personnel force.

The purpose of this study was to determine if the state-of-the-art is such that a consistent theoretical framework has been developed which reveals how economic factors transmit their effects into the AFM&PS, and if possible, how the Air Force should formulate policies to optimally respond to those environmental fluctuations. To accomplish this purpose a literature review was made of published and nonpublished studies that describe, or suggest a rationale for describing, quantitative relationships between the external labor market (ELM) and the AFM&PS. Of particular interest were studies directed toward determining whether definite relationships could be established that link the ELM with (a) career and training preferences of present and potential members of the Air Force, (b) retention rates by job and/or skill categories of current Air Force members, and (c) structural characteristics and internal behavior of the AFM&PS. It was anticipated that if sufficient information was obtained under this study to properly describe the relationship between the ELM and the AFM&PS, the results would serve as the framework for

developing an ELM module for the Integrated Simulation Evaluation Model (ISEM) of the AFM&PS.

Section II of this report contains a chronological review of selected studies considered to have an area of application to this effort. In Section III, an assessment is made as to the applicability of past studies to the development of a labor market AFM&PS interface model. Contained in Appendix A is an annotated bibliography of technical reports reviewed for this study.

II. REVIEW

Gary Nelson (in 1970) presented a theoretical and statistical analysis of first-term reenlistment in the Army. The decision to reenlist was viewed as an occupational choice between continued military service and civilian employment. Nelson's economic view of the reenlistment decision stresses the expected future military and civilian earnings facing the potential reenlistee and attempts to measure the influence of these earning expectations on reenlistment. The time when the reenlistments occurred in this study (1966 and 1967) was a period of rapid growth for the Army and of insufficient reenlistment in nearly all specialties. Consequently, the author observed the actual supply of reenlistments rather than the supply with some constraint placed by the number of openings.

Cook (1970, 1971) developed a model of military enlistment behavior, which was also based on the principle of occupational choice. While not measuring preferences directly, Cook observed the enlistment decisions of individuals and then related variations in enlistment behavior to variations in the present values of military and civilian earnings, thus, theoretically deriving a supply curve of Air Force volunteers. A unique problem presented itself in the analysis in that the attractiveness of the Air Force, both in itself and as an escape from the draft, resulted in an excess supply of volunteers. Because of this excess supply and the lack of data on the total number of

volunteers, direct estimation of the supply curve was precluded. However, in the context of the "queueing" concept of labor markets, Cook developed an adjusted supply curve from which he could infer the parameters of the actual, but not observable, supply curve of total volunteers. The adjustment consists of incorporating into the supply formulation variations in the average quality of those who enlisted as a correction for unobserved variations in the excess supply. Cook indicates that the average quality of recruits varied directly with the excess supply.

Cook and White (1972) used an econometric model to identify the principal determinants of the quality of Air Force recruits in order to provide information for planning the recruiting strategies necessary in an all-volunteer environment. By identifying these determinants and their separate and net effects on quality, personnel and manpower policies can be shaped to maintain or improve the quality of planned force structure explicitly.

Bennett, Haber, and Kinn (1972) reexamined wage and unemployment elasticities of the supply of volunteers to the United States Armed Forces, in the absence of a draft. They contend that earlier studies are misspecified due to the omission of a measure of the resources employed in manpower procurement. When a resource variable is included in the supply equation, wage and unemployment elasticities are obtained which are substantially lower than those reported in the earlier studies. This implies that volunteers may not be as responsive to wage increases as previously assumed, which could make the wage increases to maintain an all-volunteer military establishment much greater than anticipated.

In 1972, Cook and Rutherford, set forth a prediction technique developed from an earlier Rand model. They also described a computer program for translating existing data into usable information from which to predict (a) the mean input level of volunteers, and (b) a conservative and a liberal estimate of the total number of Air Force volunteers. Their program was flexible in that the user could alter the parameters of the statistical model. He could use various promotion rates (by changing the distribution of airmen by grade and years of service) as well as different levels of pay by grade and years of service.

The approach taken by Jaquette and Nelson (1974) in their manpower model was to treat military manpower policies as variables in order to

investigate higher level policy issues related to military compensation, retention, and the rate of initial accessions. Thus, their model could be used to investigate many of the factors that are held constant in other manpower models.

Grissmer, Amey, and Arms (1974) and Grissmer, Clement, and Amey (1974) developed and refined enlistment prediction models associated with the all-volunteer environment. They developed a means for identifying the marketplace profile and for its updating; also they provided a means for evaluating the propensity of this market to enlist under varying controllable and uncontrollable conditions.

Goldberg (1975) obtained estimates of the supply of enlistments using a single equation log-linear model and with state data pertaining to CY 1973. In addition to variables previously included in General Research Corporation models, such as a service's recruiters, relative military versus civilian pay, and unemployment, three additional factors were analyzed: a measure of attitudes toward the military, the racial mix of the population, and other services' recruiters.

Pope and Weideman (1975) used regression analysis to investigate selected socio-economic factors as to their effect on first-term military enlistments. Fiscal year 1974 was selected for study because it represented the first no-draft environment since World War II. Their basic findings indicated that the Department of Defense (DOD) could not rely on socio-economic pressures to induce young males to enlist in the military.

Smith and Callahan (1975) provided a frame-of-reference for viewing military work, training, and education as part of an individual's overall career development. The authors give examples which demonstrate the continuity of selected military occupations with significant, comparable civilian opportunities.

Previous studies have obtained information about the opportunities available to single-term enlisted personnel by examining data on veterans' earnings. Massell (1975) suggests that evidence obtained in this way may be misleading in that men who choose to separate from the service do so because they have relatively good civilian opportunities, and their experience may not reflect the civilian opportunities available to men who reenlist. Drawing on research by R. Gronau, Massell suggests an alternative estimation method based on a model of the reenlistment decision process.

In a staff issue paper for the Defense Manpower Commission, Abellera (1976) provides an in-depth analysis of the prospects for sustaining the peacetime all-volunteer force (1976-1985). Three supply scenarios for the period are portrayed according to moderate, slow, and rapid economic growth assumptions. According to Abellera, active force recruiting needs can be sustained without great difficulty if moderate or slow economic growth is realized.

III. CONCLUSIONS

Selected studies published during the period from 1970 through 1976 were examined to determine their applicability to the problem of simulating the interaction occurring between the ELM and the AFM&PS. Many of these studies were designed to investigate the magnitudes of the effects of variables, which could impact on the supply of volunteers and on retention rates. As a result of these studies, there is a better under-

standing of the effect of economic variables on the AFM&PS. Although information revealed by these studies is very important in explaining the interaction between the ELM and the AFM&PS, it does not provide an "off-the-shelf" methodology for building an ELM module for ISEM. Additional information is needed which explains how structural information is used in the accession and retention decisions, and which accounts for uncertainty on both the demand and supply sides of the labor market.

The results of this review suggest that for purposes of the ISEM model, information not currently available in existing methodologies is needed to properly represent the interaction that occurs between the ELM and the AFM&PS. It is therefore recommended that a basic research effort be made to provide the conceptual framework necessary to understand the interaction that occurs as the AFM&PS reacts to changes in the national labor market.

REFERENCES

- Abellera, J.W. *Prospects for sustaining the peacetime all-volunteer force, 1976-1985*. Washington, D.C.: A Staff Paper for the Defense Manpower Commission, March 1976.
- Bennett, J.T., Haber, S.E., & Kinn, P.J. *The supply of volunteers to the Armed Forces Revisited*. Report Number AD-740 402. Washington, D.C.: George Washington University, March 1972.
- Cook, A.A., Jr. *The supply of Air Force volunteers*. Research Paper RM-6361-PR. Santa Monica, CA: Rand Corporation. September 1970.
- Cook, A.A., Jr. *Occupational choice, the draft, and the excess supply of Air Force volunteers*. Research Paper P-4606-1. Santa Monica, CA: Rand Corporation, November 1971.
- Cook, A.A., Jr., & Rutherford, C.M. *A computer program and model for predicting the supply of Air Force volunteers*. Santa Monica, CA: Rand Corporation, May 1972.
- Cook, A.A., Jr., & White, J.P. *Estimating the quality of airman recruits*. Research Paper P-4763. Santa Monica, CA: Rand Corporation, January 1972.
- Goldberg, L. *Supply of enlistments: Estimates and applications*. McLean, VA: General Research Corporation, June 1975.
- Grissmer, D.W., Amey, D.M., & Arms, R.L. *An econometric analysis of volunteer enlistments by service and cost effectiveness comparison of service incentive programs*. Report Number AD-A001 033. McLean, VA: General Research Corporation, August 1974.
- Grissmer, D.W., Clement, W.L., & Amey, D.M. *An evaluation of Army manpower accession programs*. Report Number AD-919 124L. McLean, VA: General Research Corporation, April 1974.
- Jaquette, D.L., & Nelson, G.R. *The implications of manpower supply and productivity for the pay and composition of the military force: An optimization model*. Research Paper R-1451-ARPA. Santa Monica, CA: Rand Corporation, July 1974.
- Massell, A. *An imputation method for estimating civilian opportunities available to military enlisted men*. Research Paper R-1565-ARPA. Santa Monica, CA: Rand Corporation, July 1975.

Nelson, G.R. *An economic analysis of first-term reenlistments in the Army.* Report Number AD-711 609. Arlington, VA: Institute for Defense Analysis, June 1970.

Pope, M.S., & Weideman, R.F. *The effects of socio-economic factors on military enlistments in a zero-draft environment.* Report Number

AD-A006 339. Wright-Patterson AFB, OH: Air Force Institute of Technology, January 1975.

Smith, J.B., & Callahan, W.T. *Coordination and integration of military education with national career education.* Report Number ADIA-004983. Silver Spring, MD: Operation Research Inc., February 1975.

APPENDIX A: ANNOTATED BIBLIOGRAPHY

An annotated bibliography of technical reports reviewed for this study.

Abellera, J.W. *Prospects for sustaining the peacetime all-volunteer force, 1976-1985.* Washington, D.C.: A Staff Issue Paper for the Defense Manpower Commission, March 1976.

The purpose of this report is to analyze the prospects of sustaining the Department of Defense's annual requirements for new enlisted manpower from 1976-1985 by looking at the effects of three external factors: population shifts, patterns of economic growth and school enrollment rates. Sustainability prospects are assessed by characterizing the projected size and composition of a representative segment of the manpower pool from which enlisted non-prior-service accessions will come, the national 18-year-old male population. Various scenarios portraying the supply of volunteers are developed according to alternative assumptions concerning the growth of the civilian economy between now and 1985. The annual demands for 18-year-old non-prior-service accessions projected by the Department of Defense are matched against the supply of applicants forecasted in each scenario to identify potential insufficient supply situations. Also, the effectiveness of various management actions that can significantly alter supply are assessed to determine how shortfalls could be reduced by a judicious choice of responses.

Eighteen-year-olds are grouped into four categories: (1) those who elect to continue their education throughout the year, (2) those who find satisfactory civilian employment, (3) those who are institutionalized or already in the armed services, and (4) all those left over who are available (but not necessarily qualified) for enlistment. From 1971-1974 data, group 4, the resource pool, made up about 13.7% of the total 18-year-old population or about 287,000. In considering patterns of economic growth, the author relied on historical employment data from 1948-1974. These data show that the employment opportunities available to 18- and 19-year-olds remain stable or expand only when total civilian employment increases quite rapidly, tend to decline during moderate increases, and fall rapidly during a sluggish increase. The available pool is then evaluated on the basis of a constant college enrollment rate of 47%, a constant institutional rate of 3.5%, and the three economic growth scenarios. It was found that, in moderate or slow growth, the Department of Defense could expect to meet its demands. However, when the economy was growing rapidly, the Department of Defense would fall far short of its goals in recruitment. The study is concluded by discussing recommendations to bring about increased enlistments.

Bennett, J.T., Haber, S.E., & Kinn, P.J. *The supply of volunteers to the Armed Forces revisited.* Report Number AD-740 402. Washington, D.C.: George Washington University, March 1972.

This paper re-examines wage and unemployment elasticities of the supply of volunteers to the United States Armed Forces in the absence of a draft. This paper shows that earlier studies are misspecified due to the omission of a measure of the resources employed in manpower recruitment. When a resource variable is included in the supply equation, wage and unemployment elasticities based upon 1970 data are obtained which are substantially lower than those reported earlier. This finding implies that volunteers may not be as responsive to wage increases as previously assumed, which could mean that the wage increases necessary to raise an all-volunteer military establishment are much greater than anticipated. Further, consideration is given to the economic trade-off between military wage increases and increased utilization of recruiting resources, a trade-off which has been overlooked by earlier investigators.

Relative wage and unemployment elasticity estimates were made for calendar year 1970 from cross-sectional data based on 33 state groups for the Marine Corps, 27 for the Air Force, and 29 each for the Army and Navy. The dependent variable is the first-term enlistment rate and the independent variables are the ratio of military to civilian wages, $W = W_m/W_c$, where W_m represents regular military compensation and W_c is the estimated annual wage of production workers in manufacturing, and the aggregate unemployment rate, U . The observation units for which variables are measured are state groups corresponding to service recruiting markets. Four functional forms were fitted; i.e., linear, log-linear, complement, and semi-log. The estimates varied only slightly by functional form.

The weighted average wage elasticity from this study for all volunteers based on 1970 data is 0.82 (a previous study by Gilman (1970) had asserted it to be 1.25). When the resource variable is taken into account in the model, the weighted average wage elasticity declines further to 0.62—slightly less than half of the 1.25 value. This suggests that the wage increases required to raise an all-volunteer force are substantially greater than previously suggested.

With respect to the responsiveness of volunteers to changes in the unemployment rate, Klotz (1970) asserted that the unemployment elasticity may be as high as 0.62. In the present study, the unemployment elasticities are found to depend upon the specification of the model and to vary by service. When the recruiter resource is considered, the unemployment elasticity is significantly different from zero only for the Air Force; for this service, it is only 0.34. The authors conclude, therefore, that over all military services the unemployment elasticity is quite small.

The inclusion of the resource variable in the model not only alters the wage and unemployment elasticities, it also produces a marked increase in the explanatory power of the model as measured by the adjusted coefficient of determination. The resource elasticities are highly significant statistically for all services and large in magnitude relative to wage elasticities. It is clear that for each service an economic trade-off exists between military wage increases and increases in expenditures for manpower procurement resources.

Cook, A.A., Jr. *The supply of Air Force volunteers*. Research Paper RM-6361-PR. Santa Monica, CA: Rand Corporation, September 1970.

This study describes an investigation of the factors that influence the supply of Air Force volunteers. To estimate the cost of fulfilling the given manpower requirements, it was necessary to estimate a supply curve of volunteers to the Air Force. A model of airmen supply is developed in the context of occupational choice. Although data limitation preclude the direct estimation of the model's parameters, parameters can be inferred by considering the equilibrating mechanism used by Air Force recruiters in procuring non-prior-service airmen. The Air Force traditionally satisfies its manpower requirements. In doing so, it allows the quality of its recruits to vary; this assures an equilibrium between the manpower requirements and the volunteer supply.

The supply curve that results from the model is empirically estimated using quarterly data, which explicitly considers changes in expected military and civilian earnings and the diverse effects of draft pressure on young men. The elasticity of supply of volunteers with respect to the military-civilian pay ratio is estimated to be 2.19, implying that an additional two percent of the pool of eligible young men volunteer for a one-percent change in the military-civilian pay ratio. The elasticity of supply with respect to unemployment has an insignificant effect.

Estimates were made in this study by a least-squares regression method and using quarterly time series data from the first quarter of 1958 through the second quarter of 1967.

Cook, A.A., Jr. *Occupational choice, the draft, and the excess supply of Air Force volunteers*. Research Paper P-4606-1. Santa Monica, CA: Rand Corporation, November 1971.

Cook has developed a model of military enlistment behavior based on the principle of occupational choice. While not measuring tastes directly, Cook observed the enlistment decisions of individuals and then related variations in enlistment behavior to variations in the present values of military and civilian earnings, thus theoretically deriving a supply curve of Air Force volunteers. But the attractiveness of the Air Force, both in itself and as an escape from the draft, has resulted in an excess supply of volunteers. Because of this excess supply and the lack of data on the total number of volunteers, direct estimation of this supply curve was precluded. However, in the context of the "queueing" concept of labor markets, Cook developed an adjusted supply curve from which he can infer the parameters of the actual, but not observable, supply curve of total volunteers. The adjustment consists of incorporating into the supply formulation variations in the average quality of those who enlisted as a correction for unobserved variations in the excess supply. Cook indicates that the average quality of recruits (those volunteers who were actually accepted into the Air Force) varied directly with the excess supply. The greater the excess supply of volunteers, the greater the average quality of recruits.

In describing the results of the statistical estimation of parameters of the supply equation, Cook presented the parameters of four equations. The four equations differ in that each considers a different range of quality for the volunteers. Each quality range further assumes an excess supply different from the other quality ranges. The results of estimating these four equations highlight at least two very interesting points. First, the magnitude and the importance of the quality adjustment vary significantly across the four supply equations and are directly related to the magnitude of the excess supply. The "shift" in the supply curve due to the excess supply of volunteers and the Air Force's "creaming" process carries from a "quality elasticity" of 3.18 (and statistically significant) for the greatest amount of excess supply, to a "quality elasticity" of 0.15 (not statistically significant) for the least amount of excess supply. Secondly, the elasticity of supply with respect to the military-civilian earnings ratio is substantially larger than that observed in previous studies. The estimated elasticity of approximately 2.19 is larger than the highest previous elasticity of 1.36 (obtained by W. Y. Oi, 1967).

Cook obtained values for his estimating equation by least-squares regression using quarterly time-series data from the first quarter of the 1958 through the second quarter of 1967.

Cook, A.A., Jr., & Rutherford, C.M. *A computer program and model for predicting the supply of Air Force volunteers.* Santa Monica, CA: Rand Corporation, May 1972.

To help the Air Force understand the enlistment behavior of volunteers and to assess the feasibility of an All-Volunteer Armed Force, a model was developed in earlier Rand studies to explore the rationale young men use in making their enlistment decisions in terms of the advantages of military and civilian life. Briefly, the model determines the supply of volunteers as a function of the expected net advantage of military life relative to civilian life, the unemployment rate in the civilian economy, and draft pressure. Two Rand Memorandums published in September 1970 detail the model and subject matter: Cook and White, "Estimating the Quality of Air Force Volunteers" and Cook, "The Supply of Air Force Volunteers."

The current report describes a prediction technique developed from the earlier model. It contains a computer program which translates existing data into the format necessary to predict (a) the mean level of volunteers, and (b) a conservative and a liberal estimate of the number of volunteers.

The program is flexible in that the user can alter the parameters of the statistical model if he desires. He can use various promotion rates (by changing the distribution of airmen by grade and years of service) as well as different levels of pay by grade and years of service. Each user can provide his own assessment of civilian pay by age as the data become available and can furnish whatever rates of pay increases (both civilian and military) seem appropriate. Additional options are in the ability to use varying possible age distributions of enlistees and the ability to adjust the available pool of potential volunteers. In short, the user can update both the statistics and the model in each subsequent period (which must be done to maintain the validity of the prediction process); and he can predict the number of volunteers, by mental categories, for possible future scenarios.

The report describes the program logic and documents the initiation of various available options. Finally, it presents an example to show the precise working of the program and to highlight its flexibility.

Cook, A.A., Jr., & White, J.P. *Estimating the quality of airman recruits.* Research Paper P-4763. Santa Monica, CA: Rand Corporation, January 1972.

To determine the variation in recruit force quality, the authors use an economic model to derive a quality supply curve, which can be used to predict quality changes in recruits and, by extension, in volunteers, as a function of the draft and economic considerations. The authors have not considered any changes in the present (1972) recruiting procedures, the existing test procedures, or the methods of setting and meeting the manpower requirements in any given period. They constructed the model solely within the confines of Air Force established institutional arrangements. Within this framework they can consider plausible changes in the draft and the economic environment and explain the changes in recruit quality by means of an estimated supply curve.

In the report, Section I discusses the demand for recruits and the selection process for choosing volunteers as enlistees. Section II describes the volunteer supply in terms of occupational choice as well as the variables that affect recruit supply and quality. Section III contains the specifications of the model.

Then Section IV defines the variables used in the analysis, and Section V contains the estimation of the supply of quality parameters. Finally, Section VI summarizes the results of the model and its estimation. By couching the results in the framework of a hypothetical but plausible scenario, it is shown how the model can be used to determine a specified quality level and to estimate the cost of achieving such a level.

Time-series data were used to estimate the parameters. The data consist of quarterly observations from the first quarter of 1959 through the second quarter of 1967. Quantification of the specified variables was obtained in a least-squares regression. The earnings ratio (military/civilian) is the most significant variable for quality changes and has the largest elasticity. This result is important because it indicates that recruit quality does respond to pay increases and provides the Air Force with a device for controlling enlistee quality.

Goldberg, L. *Supply of enlistments: Estimates and applications.* McLean, VA: General Research Corporation, June 1975.

General Research Corporation (GRC) analysts have continued their efforts to improve the methodology and data utilized to estimate the supply of enlistments. This paper reports on the preliminary findings of recent GRC estimates of the supply of enlistments. Special attention is given to the determination of the impact on enlistments of recent increases in unemployment.

Estimates of the supply of enlistments are obtained by Service using a single equation log-linear model estimated with state data pertaining to CY 1973. In addition to variables previously included in GRC models, such as a service's recruiters, relative military versus civilian pay, and unemployment, three additional factors have been analyzed: a measure of attitudes toward the military, the racial mix of the population, and other Service's recruiters. Briefly, the findings with respect to these variables are as follows: Recruiters have a positive effect for all the services although the magnitude of the recruiter elasticity and the statistical significance varies across the services. Attitudes toward the military and other services' recruiters have consistent effects for all services except the Marine Corps. As attitudes improve, enlistments increase; as other services' recruiters increase, enlistments increase, indicating that there may be positive effects of interservice competition for enlistments. The percentage of blacks in the population has a negative and statistically significant effect for the Air Force and Navy. Pay has a positive and significant effect for the Army and Air Force and no effect for the other services. Finally, unemployment has a statistically significant impact for all services except the Marine Corps.

The results are compared to previous GRC estimates of the supply of enlistments with respect to the recruiter, pay, and unemployment elasticities in order to assess the impact of the inclusion of the three additional factors. The revised specification appears to eliminate a downward bias with respect to the estimation of the pay variable. Estimates of the unemployment elasticity are positive and yield a more reasonable pattern across the services. The estimates of the recruiter elasticity changed substantially for all the services except the Army.

The regression results were utilized to determine the number of unemployment-induced contracts under alternative national unemployment scenarios. Supply functions are used to estimate the marginal productivity of recruiters and the potential recruiting resources cost savings due to recent increases in unemployment. The results indicate a potential cost savings of approximately \$100 million.

Grissmer, D.W., Amey, D.M., & Arms, R.L. *An econometric analysis of volunteer enlistments by service and cost effectiveness comparison of service incentive programs.* Report Number AD-A001 033. McLean, VA: General Research Corporation, August 1974.

This report contains an evaluation of manpower programs and policies which were implemented primarily to achieve the transition from a conscripted to an all-volunteer Armed Service. The basic purpose of the study was to determine the cost effectiveness of various enlistment programs in attracting additional volunteers to each service. The analysis was also aimed at determining the effects of changes in youth unemployment rates, college entrance patterns and various service manpower policies on volunteer enlistments in each service as well as the interservice effects of one service's programs on enlistments in other services. Three different methods of analysis were used to determine program and policy effects. Included were an econometric model of volunteer enlistments by state, a monthly econometric time-series model, and an analysis of survey data which was used to estimate the effectiveness of a combat arms bonus. A discussion of the first two of these methods will now be presented.

Econometrics Model of Volunteer Enlistment by State

The models used in this analysis are similar to models previously presented by other analysts in that they regress the rates of volunteer accessions per qualified military available (QMA) against the variables of relative military pay, rate of unemployment, and amount of recruiter productivity. The primary differences are in the definitions of the variables and the inclusion of two additional explanatory variables and use of 1972 and 1973 volunteer data. Specifically these differences are:

1. Unemployment rates in this study are disaggregated into rates for 17- to 18-year-olds and 19- to 21-year-olds.
2. The relative military wage is constructed using the ratio of the discounted present value of military pay to the discounted present value of the expected minimum of civilians in each age group. A 3-year time period is used for both military pay and civilian pay.
3. The two additional independent or explanatory variables are: (a) the ratio of male high school graduates to male college enrollments, and (b) the ratio of military to civilian citizens.
4. Cross-sectional data by state were used for all four services and DOD total.

The general form of the model used for the four services and DOD total is given as:

$$Y_{ij} = f[W_i, U_i, R_{ij}, H_i, M_i]$$

where:

i is the subscript identifying the state, $i = 1, \dots, 47$ (47 includes the District of Columbia but excludes New York, New Jersey, Hawaii, and Alaska for technical reasons)

j is the subscript identifying the services, $j = 1, \dots, 5$

Y_{ij} is the number of first-term volunteer enlistments per 1000 QMAs per state for the j th service

W_i is the relative military wage; i.e., the ratio of military wages to civilian wages, per state

U_i is the rate of unemployment per state per age group, 17-18 or 19-21

R_{ij} is the number of recruiters from the j th service per 1000 QMA per state

H_i is the ratio of male high school graduates to the number of male college enrollments per state

M_i is the ratio of military residents to the total number of residents per state

A stepwise regression program was used and, in all, 80 regression fits were made. Eight different models based on age, mental category, education, and race were estimated for each service and DOD total for both calendar years 1972 and 1973. The models are as follows:

1. 17- through 18-year-olds
2. 19- through 21-year-olds
3. Mental Category I-II
4. Mental Category I-III
5. High school graduates
6. Non-high school graduates
7. High school graduates - black
8. Non-high school graduates - black

Initially, the data were fitted to three mathematical forms ... linear, log-linear, and semi-log. Since the elasticities derived from each form were not significantly different, the linear model was used in all cases and is given as:

$$Y_{ij} = B_0 + B_1 W_i + B_2 U_i + B_3 R_{ij} + B_4 H_i + B_5 M_i \quad \text{where: } i = 1, \dots, 47 \\ j = 1, \dots, 5$$

Although runs for each service and for DOD were made, only a brief analysis of the Air Force run will be listed here.

Unemployment Elasticities

1. Unemployment did not have a significant impact on volunteer accessions in 1972 but did in 1973.
2. Unemployment elasticities were consistently higher for 19- to 21-year-olds from 17- to 18-year-olds and for Mental Category I-II than Mental Category I-III. They were also consistently higher for high school graduates than non-high school graduates.

The non-significance or negative impact of the unemployment variable in 1972 may be explained in part by the fact that the Air Force had not experienced difficulty in meeting its recruiting requirements and in effect queues had built up for entrance into the service; consequently, real change in unemployment would have the impact of lengthening or shortening the queue and volunteer rates would not be affected until the queues diminished. Thus, observed changes in the unemployment rates would not appear as significant in the regression models under these conditions.

The shift in significance in unemployment in 1973 may be explained in part by the fact that many of the volunteers in 1972 were draft-motivated, whereas in 1973 they were purely volunteers. The result is that the Air Force demand for volunteers was less in 1972 and queues existed. However, in 1973 the Air Force demand for volunteers increased so that queues might have disappeared in certain areas, and unemployment was measured as significant even though unemployment rates dropped from 1972 to 1973.

Recruiter Elasticities

1. The recruiter elasticity was positive and significant in all cases in 1972 and 1973.
2. There was no difference in recruiter elasticity between 1972 and 1973, nor by age in 1972.
3. The recruiter elasticity was higher for 17- to 18-year-olds than 19- to 21-year-olds in 1973.
4. The recruiter elasticities were consistently higher for Mental Category I-III than Mental Category I-II and consistently higher for non-high school graduates than high school graduates.

The average elasticities for all categories in 1972 was .828 and the average in 1973 was .757. This slight decline may be explained by the fact that the Air Force recruiting strength was about one-third less in 1973 than 1972, even though the number of volunteer enlistments remained the same.

Other Variables

1. The relative pay elasticity was not significant for 1972 or 1973.
2. The high school to college ratio elasticities were positive and significant for 1972 and 1973.
3. The military population density elasticities were negative and significant in 1972, but were significantly greater in 1973 with 19- to 21-year-olds and non-high school graduates having positive elasticities.

The elasticities obtained in this analysis must be interpreted with caution because of the inherent uncertainties and inadequacies associated with using the general linear regression model. In the first instance the values obtained for the coefficients of multiple correlation (R^2) are not very large, and in the second instance the sample variances for the regression coefficients are relative large. While the values obtained in this study compare favorably with those found in previous studies, the implication is that there is a substantial amount of variation in the dependent variable (the rate of first-term volunteer enlistments) which is not explained by the model.

Time-Series Regression Model

The regression model used in this analysis differs from the standard linear model in that the seasonal dummy variables are multiplicative rather than additive and a non-linear regression technique is used to solve for the coefficients simultaneously. For the Air Force, regression runs were made using CY 1971 through CY 1973 time series of the following groups as dependent variables:

High school graduate volunteers of Mental Categories I, II, III, and IV.

High school graduate volunteers of Mental Categories I-III and I-IV groups.

Explanatory variables included Military/Civilian wage, number of recruiters, bonus variables, print media advertisements, unemployment rates, and interservice variables. The results of an analysis of the regression runs are presented next.

Among the Air Force volunteers, an increase in military pay relative to civilian wages caused an increase in Mental Category I-III high school graduate accessions and had no significant effect on non-high school or category IV high school graduates. Pay elasticities for Category I high school graduates ($.91 \pm .13$) are significantly higher than the elasticities for Category II ($.69 \pm .11$) and Category III ($.35 \pm .25$) high school graduates. The lower elasticities and significance for the Category III group reflect that this group was probably demand-limited during this time period.

The response to recruiting by Mental Category I, II and III high school graduates is quite large, with elasticities ranging from .87 to 1.29. Recruiting had no significant effect on Category IV high school graduates or Category I-III non-high school graduates. The results show generally larger elasticities for the higher mental groups. Lower elasticities for Category III high school graduates probably indicate that this group was demand-limited during part of the 3-year time period considered.

Of the other variables considered, i.e., new options for Air Force enlistees, unemployment rates, combat bonus programs for the Army and Marine Corps and print media advertisements, all were of very minor importance in explaining variation in volunteer enlistments in the Air Force. However, there was one interservice variable which was generally significant. During June-September 1972, the monthly quota for males in the Navy almost doubled over previous months, from around 7,500 to 14,000. This doubling of the quota caused a loss of Air Force Category I-III high school graduate enlistments of 650 per month. Roughly, for each change of 1000 in the monthly Navy quota, Air Force Category I-III high school graduate enlistments changed by 100.

Conclusions from an analysis of the time-series model indicate that for the Air Force, all non-high school graduate groups and Category IV high school graduate groups were demand-limited; i.e., the Air Force could increase (at that time) enlistments in these groups with simple policy changes. There was also evidence that the Category III high school graduate group was also demand-limited.

Analysis of the cost effectiveness of the combat arms bonus based on Armed Forces examining and entrance stations survey data will not be discussed in this report since it was applied only to Army and Marine volunteers and did not significantly affect changes in Air Force volunteers. A definitive comparison of elasticities from different measurements is not valid since the measurements were made in different time periods and used different models and variables.

Grissmer, D.W., Clement, W.L., & Amey, D.M. *An evaluation of Army manpower accession programs.* Report Number AD-919 124L. McLean, VA: General Research Corporation, April 1974.

This study covers cost-effectiveness analysis of Army incentive programs, analysis of volunteers' quality, a monitoring and projection system for enlistments, analysis of unemployment effects on volunteer enlistments and analysis of reenlistments. The analysis covered the period from September 1972 through August 1973. The portion of this study which addresses the unemployment effects on volunteer Army enlistments will be the main topic covered by this review.

Summary of Previous Studies - Unemployment Impact

In principle one would expect to observe a positive relationship between Army (or other services) first-term volunteer enlistments and unemployment rates. However, the findings of previous elasticity studies do not substantiate this hypothesis. An examination of the aggregation methodology used in previous studies suggests that significant variables were omitted from these models and a finer grain of disaggregation is required. Bennett, Haber, and Kinn have taken a step in the right direction by incorporating the recruiter productivity variable. However, their results are obscured by the use of aggregate unemployment data which include all age groups. In addition they used manufacturing wages to represent the civilian component of the pay variable instead of the average compensation received by individuals from 17 to 21 years of age.

The authors of this study have made improvements over previous studies by including a finer grain of data disaggregation, the inclusion of a variable representing the number of high school graduates who go to college, and a variable representing the percentage of military residents in each region.

The models of Fechter (1970), Altman (1969), Gray (1970), and Binkin and Johnston (1973) did not include a variable representing recruiter productivity, and as Bennett, Haber, and Kinn (1972) conclude, the elasticities of both wages and unemployment are likely to be biased upward. Bennett, Haber, and Kinn included a variable for recruiter productivity and found it significant in all cases at the 90 percent level. Also, they found the unemployment elasticities to be quite small and not significant. However, they used unemployment figures which included all age groups of the population and was not necessarily representative of the age groups relevant to Army enlistments. It can be demonstrated that the variation in unemployment rates for 17- to 21-year-olds is substantially greater than the variation in unemployment rates for the whole population.

The Current Model

The models used in this analysis are similar to the models used by Bennett, Haber, and Kinn in that they regress the rates of volunteer accessions per QMA against the variables of relative military wage, rate of unemployment, and amount of recruiter productivity. The primary differences are in the definition of the variables and the inclusion of two additional explanatory variables and use of 1972 volunteer data. Specifically these differences are:

1. Unemployment rates in this study are disaggregated into rates for 17- to 18-year-olds and 19- to 21-year-olds.
2. The relative military wage is constructed using the ratio of the discounted present value of military pay to the discounted present value of the expected minimum of civilians in each age group. A 3-year time period is used for both military pay and civilian pay.
3. Volunteer rates and recruiter productivity are measured in two ways. The first is the rate per QMA and the second is the rate per military available (MA).
4. The two additional independent or explanatory variables are: (a) the ratio of male high school graduates to male college enrollments and (b) the ratio of military to civilian citizens.
5. Cross-sectional data by Recruiting Main Station (RMS) for CY 1972 were used.
6. 1972 volunteer data, the first full year of data since the pay raise, were used.

Using RMS data meant that the state data for wages, unemployment, high school graduates, and military populations had to be converted. The decision to use RMS data rather than state data was made because RMS boundaries cross state boundaries and it was felt that it would be easier to convert the state wage and unemployment data to RMS data than it would be to convert recruiter productivity data by RMS data for each state.

The general form of the model is given as:

$$Y_i = f[W_i, U_i, R_i, H_i, M_i] \quad i = 1, \dots, 32$$

i = The subscript identifying the RMS

Y_i = The number of first-term volunteer enlistments per 1,000 QMAs or MAs per RMS

W_i = The relative military wage; i.e., the ratio of military wages per civilian wages, per RS

U_i = The rate of unemployment per RMS per age group; i.e., 17-18 or 19-21

R_i = The number of Army recruiters per 1,000 QMAs or MAs per RMS

H_i = The ratio of male high school graduates to the number of male college enrollments per RMS

M_i = The ratio of military residents to the number of total residents per RMS

The mathematical forms used in data fitting were linear and log-linear. A stepwise regression program was used and, in all, 24 regression fits were made. Eight fits were made with the variables for wages, unemployment, and recruiter productivity, and 16 fits were made which added variables to represent the number of male high school graduates who go to college (H_i) and the percentage of military population in the region (M_i). The rationale for including the ratio of male high school graduates to college enrollments is based on the assumption that the propensity of a high school graduate to enlist is less if he goes to college.

Presumably, a high ratio will be associated with a high percentage of volunteer enlistments. Regression results confirmed this hypothesis. The rationale for including the percentage of military population in each region is based on the premise that the career selections of young individuals are influenced by the careers of parents and friends. If a large proportion of the population in a region is employed by the military, then there should be a higher probability that career choices will be made in favor of the military than if there were a smaller proportion of military population. Since the main purpose of this review is to focus upon unemployment elasticities, only a brief summary will be given for the elasticities for wages, recruiter productivity, high school graduates and military population.

In general the wage elasticities are less than those found in previous studies. The average wage elasticity was found to be .627 and in two cases it was found to be not significantly different from zero. The recruiter productivity variable was found to have the greatest impact and it was significant at the 90 or 95 percent level in 12 of the 24 cases. The average recruiter elasticity was found to be 1.104. The average elasticity for the high school graduate variable was .245 and the average elasticity for the military population variable was .069.

Conclusions drawn from an analysis of unemployment elasticities are summarized as follows:

1. Unemployment elasticities are greater than previous studies indicate. The average value was found to be .328.
2. Unemployment elasticities are greater for 17- and 18-year-olds than for 19- to 21-year-olds. (.443 vs. .212).
3. Unemployment elasticities are greater for mental groups I-II than for mental groups I-III (.416 vs. .239).
4. The elasticity calculations are insensitive to changing measurement standards from QMAs to MAs (.321 vs. .341).

If the average unemployment elasticity of .328 is accepted as the best estimate, then it can be seen that the decline in unemployment rates during the last year evaluated account for a significant amount of the shortfall in first-term accessions. From July 1972 to July 1973, the unemployment rate for 18- to 24-year-old males declined 11.54 percent. Coupled with an average unemployment elasticity of .328, the estimated decline in first-term volunteer accessions is 3.79 percent, $[(11.54) (.328) = 3.79]$.

If Mental Category I-II is equated with high school graduates, then the higher elasticity of .416 would imply that the decline in the level of unemployment explains 4.8 of the percentage points of the shortfall in high school graduate volunteers; i.e., $[(11.54) (.416) = 4.8]$. Also, the elasticity of .239 for Mental Category I-III would explain 2.8 percentage points of the shortfall in this group; i.e., $[(11.54) (.239) = 2.8]$. The higher unemployment elasticity of .443 for 17- to 18-year-olds can be used to explain 5.1 of the percentage points of the shortfall in this group, and the employment elasticity of .212 for 19- to 21-year-olds can be used to explain 2.4 of the percentage points of the shortfall in this group.

The implication of this analysis with respect to Army recruiting is apparent. The Army must accept unemployment rates as given at any instant of time. However, unemployment rates do fluctuate with fluctuations in the economy and in order to meet the requirements for volunteer accessions the recruiting command must anticipate fluctuations in the economy. When economic growth is strong and unemployment rates are expected to decline, a stronger emphasis must be placed on recruiting, and when economic growth is slowing and unemployment rates are expected to rise, the level of recruiter effort can be relaxed. Unfortunately, the unemployment rates for 17- to 21-year-olds are more sensitive to changes in the level of economic activity than the unemployment rates for all age groups, and small changes in economic activity will be associated with relatively large changes in unemployment rates for 17- to 21-year-olds.

Jaquette, D.L., & Nelson, G.R. *The implications of manpower supply and productivity for the pay and composition of the military force: An optimization model*. Research Paper R-1451-ARPA. Santa Monica, CA: Rand Corporation, July 1974.

In this report a mathematical model of military manpower is developed to describe the dynamic flow of personnel within the system, which can then be used to determine optimal military wage rates and

lengths of service under steady-state and long-run conditions. The flows of men within the system reflect enlistments and reenlistments governed by military pay rates. Steady-state pay rates are chosen to maximize the level of military effectiveness subject to an annual budget constraint. The level of military effectiveness is a function of the quantities and experience levels of military manpower.

The approach taken in the manpower model presented here is to treat military manpower policies as variables to investigate higher-level policy issues related to military compensation, retention, and the rate of initial accessions. Thus, the model can be used to investigate many of the factors that are held constant in other manpower models. This model seeks to determine the optimal composition of the military enlisted force by term of service. The optimal force is defined as that force which provides the greatest military capability for a given budget cost.

A steady-state solution is found which chooses rates of military compensation to determine a pattern of enlistment rates. This pattern yields the optimal size and composition of the military force. An operations research technique called gradient search—a type of non-linear programming—is used to achieve a computer-based solution to the problem. Assumptions and formulations used to develop the mathematical relationships between pay levels and enlistment and reenlistment rates are applicable and relevant to understanding the effect of the external labor market on the force structure.

Massell, A. *An imputation method for estimating civilian opportunities available to military enlisted men.* Research Paper R-1565-ARPA. Santa Monica, CA: Rand Corporation, July 1975.

With an all-volunteer armed force, the Department of Defense must compete with civilian employers to obtain and retain skilled manpower. Thus, information about civilian employment opportunities is useful to military decision-makers. To obtain information about the opportunities available to single-term enlisted personnel, previous studies have examined data on veterans' earnings. Recent studies of civilian labor force behavior have suggested, however, that evidence obtained in this way may be misleading; the premises underlying the studies suggest, in particular, that men who choose to separate from the military do so because they have relatively good civilian opportunities, so that the experience of these veterans may not be representative of the civilian opportunities available to those who reenlist.

The present report describes the conditions under which this criticism is relevant to studies of veterans' opportunities. Specifically, it is shown that, if civilian returns are stochastic, veterans' experiences will provide (upward) biased estimates of average civilian returns available to enlisted men.

Drawing on research by R. Gronau (1973), the report then suggests an alternative estimation method based on a model of the reenlistment decision process. The proposed estimation method uses data on retention rates, military pay, and characteristics of enlisted men to estimate the average value of civilian offers. Notably, because the method does not require data on the civilian experiences of veterans, it avoids the incidental problems of determining civilian earnings of veterans who enter schooling or who are unemployed.

Finally, the report illustrates the method using data for a selected sample of men who made reenlistment decisions in fiscal year 1972, and were in Air Force electronics specialties. Results obtained by means of the empirical analysis suggest a reenlistment supply elasticity for these men in the range of 1.5 to 2.5. The estimates also suggest that a 55-percent increase in second-term pay would induce retention rates near 0.5 for men without dependents.

The reported empirical results are illustrative, based on several simplifying assumptions. However, the results are reassuring in that the estimates appear reasonable and the estimating equations yield quite good statistical properties.

Nelson, G.R. *An economic analysis of first-term reenlistments in the Army.* Report Number AD-711 609. Arlington, VA: Institute for Defense Analysis, June 1970.

This research paper presents a theoretical and statistical analysis of first-term reenlistments in the Army. The decision to reenlist is viewed as an occupational choice between continued military service and civilian employment. This economic view of the reenlistment decision stresses the expected future military and civilian earnings facing the potential reenlistee and attempts to measure the influence of these earning expectations on reenlistment. Non-income effects on retention are also discussed.

The sum of all individual reenlistment decisions constitutes the supply of reenlistments to the Army. The statistical analysis provides estimates of this supply as a function of estimated earnings and other factors. The data for the study come from the first reenlistment decisions of Army enlistees who entered military service in 1964. The observations for the statistical analysis consist of 300 groups of enlisted men classified by level of education, mental test score, race, and military occupational specialty. Army personnel tapes, which provided data on individual reenlistments, were used to estimate military pay. The Current Population Survey of 1967 and a Department of Defense survey of recent separations provided estimates of civilian earnings ability.

The time when the data reenlistments occurred (1966 and 1967) was a period of rapid growth for the Army and of insufficient reenlistments in nearly all specialties. All eligible enlisted men who wanted to reenlist were able to do so. Consequently, in this observation of reenlistments the author observed the actual supply of reenlistments in each group rather than the supply with some constraint placed by the number of openings.

The basic element of the method used in this study for treating the reenlistment decision is the critical value of the ratio of military to civilian pay. This value, which is determined by individual tastes for military service, is the minimum ratio of military to civilian pay required for an individual to reenlist. Men who are strongly inclined to military service will reenlist for a pay ratio having a value smaller than one, while the critical ratio of other men may require military pay to exceed expected civilian earnings. The distribution of critical values in a sense determines the supply of reenlistments. The proportion of a group willing to reenlist, i.e., the supply of reenlistments, is the proportion for whom the expected ratio of military to civilian pay exceeds the critical ratio. The shape of the cumulative distribution of critical values is the same as the shape of the supply curve. While there is likely to be a great dispersion of critical values, there may be a slight tendency for these to cluster around an intermediate pay ratio and then to thin out in the direction of zero infinity.

In performing this statistical study, Nelson classified Army personnel who enlisted in calendar year 1964 according to either military or civilian earnings ability. Earnings for enlisted men with the same length of service vary chiefly by military occupation. Civilian earnings of former service personnel and members of the labor force as a whole vary by level of education, mental test score, and race. Classification on the basis of these four characteristics yields about 300 groups of enlisted personnel which are internally relatively homogeneous with respect to earnings ability. Nelson calculated the discounted value of expected earnings streams in both military and civilian employment. By comparing the ratios of these discounted earnings streams with the actual reenlistments from each group, it was possible to observe points on the supply of reenlistments stemming from the distribution of critical values. In this study, data so derived were used to estimate a supply of reenlistment functions.

Two primary conclusions derived from the statistical estimation of the supply of reenlistments are:

1. The reenlistment rate is strongly influenced by variations in both estimated military and civilian earnings. While there is some evidence of a different response to military and civilian earnings, the results indicate that a 10-percent change in the ratio of military to civilian pay may affect reenlistments by 20 to 30 percent.
2. Reenlistment rates for whites are dramatically lower than reenlistment rates for blacks; the study offers evidence that differences in civilian earning ability is the primary reason for this gap.

Pope, M.S., & Weideman, R.F. *The effects of socio-economic factors on military enlistments in a zero-draft environment*. Report Number AD-A006 339. Wright-Patterson AFB, OH: Air Force Institute of Technology, January 1975.

This study uses regression analysis to investigate selected socio-economic factors as to their effect on first-term military enlistments. Fiscal year 1974 was selected for study because it represented the first no-draft environment since World War II. The basic findings of the study indicate that the Department of Defense cannot rely on socio-economic pressures to induce young males to enlist in the military. The services, now competing directly with civilian industry, must focus on making enlistments competitively attractive.

The researchers selected five factors to be considered as independent variables in the regression model. The factors were: (1) the number of recruiters from each of the military services, (2) per capita income, (3) average unemployment rate, (4) mean educational level, and (5) the percentage of non-whites in the 17- to 21-year-old male population. Data relating to these factors were obtained for each of the fifty states. A sixth factor, the population of 17- to 21-year-old males per state, was used in the formulation of the dependent variable.

The model is built around the basic equation:

$$Y_i = B_0 + B_1 X_{i1} + B_2 X_{i2} + \dots + B_m X_{in} + E_i$$

where Y_i is the number of enlistments in the i th sample observation, $X_{i1} \dots X_{in}$ are the socio-economic variables on the i th observation, and $B_0 \dots B_m$ are unknown coefficients of the independent variables estimated by the least-squares method. Additionally, the underlying assumptions of the regression model are: (1) The error term E_i has a zero mean (2) The variance of Y_i equals σ^2 for all i (3) Each Y_i observation is independent of the others.

The BMD02R Stepwise Regression Program used in this study computes a series of linear regression equation in a sequential manner. Initially, the program selects the independent variable which explains the largest amount of variation in the dependent variable and calculates the regression relationship that exists between them. Each succeeding independent variable is selected using the same criterion. As each of the independent variables is considered, the program computes the coefficient of correlation (R), the standard error of the estimate ($Sy.x$), and an analysis of variance which includes the degrees of freedom used, the sum of the squares, and the overall F ratio. Additionally, the value of the constant and coefficients, standard errors, and "F to Remove" values of the independent variables are calculated at each step.

Five models were developed to test the major hypothesis. The models tested enlistments for the Army, Navy, D.O.D., Marines, and Air Force. Summary results for the DOD and Air Force models follow. For DOD model, the F ratio was 5.924 which indicates that, with better than 99.9% certainty, there is a relationship between the independent variables tested and the dependent variable. The total RSQ value of .3970 indicates that the five independent variables are explaining 39.7% of the variation in the dependent variable. In the stepwise regression procedure, the first independent variable entered was per capita income which explained 34.84% of the dependent variable variation. The remaining four variables explained only an additional 4.86% of the variation.

The Air Force model had an F ratio of 4.580 which indicated with a 99.5% confidence that there is a relationship between the dependent and independent variables. The total RSQ value (.3373) shows that the five independent variables are explaining 33.73% of the variation in the dependent variable. Of this figure, per capita income (.2516) and mean educational level (.0712) account for 32.28% while the percentage of non-whites, the number of recruiters, and unemployment rate supply the remaining 1.45%.

It should be pointed out that for both the DOD and Air Force models, the per capita income variable produced a negative coefficient indicating that, as the mean per capita income goes down, enlistments in that area group increase. Also, it can be hypothesized that some internal Air Force recruiting policy, or some personal motivational factor prevalent among those with higher levels of education is responsible for the percentage of Air Force enlistments increasing with higher educational levels.

Smith, J.B., & Callahan, W.T. *Coordination and integration of military education with national career education*. Report Number ADIA-004983. Silver Spring, MD: Operations Research Inc., February 1975.

The purpose of this study has been to provide a frame of reference for viewing military work, training and education as a part of an individual's overall career development. In addition, this study was to prepare examples which demonstrate the continuity of selected military occupations with significant, comparable civilian opportunities.

The study approach consisted of the following procedures:

- * In-depth examination of military career ladders for four selected military occupations (in avionics), one from each military branch, similar to each other in task content.

- * Comparison of those four military career ladders with four civilian career ladders in similar avionics occupations. Comparisons were made concerning technical job content, managerial job content, and entry requirements in the categories of formal education, work experience, vocational/technical training and licensing or certification prerequisites.
- * Identification of the military occupations which deserved priority attention based on the fact that some occupations employ large number of persons but require very little, if any, formal training. This procedure required that all military occupations be ranked by their personnel density and by the length of formal training provided.
- * Selection of 24 military occupations for further study.
- * Collection, classification and collation of information on the first enlistment term, work and training experience of persons in these military occupations and identification of the educational opportunities of these persons while serving.
- * Collection, classification and collation of information on three civilian sector occupations that are similar to each of the 24 military occupations or portions of those occupations.
- * Comparison of the military and civilian sector occupations based on the following categories of requirements: formal education, vocational/technical training, previous experience, licensing or certification and union apprenticeship/journeyman.

Findings and Recommendations

- * Military and civilian occupations can be compared in a coherent manner.
- * Comparison of military experience with the employment requirements of civilian sector occupations demonstrates the degree of career continuity between the sectors.
- * The comparisons produced may prove useful to policy-makers, planners, personnel recruiters, and recruits.
- * DOD should consider expanding the number of military occupations that are compared, in-depth, with civilian career development requirements.
- * Expansion of the information base should be established entirely on the basis of personnel density per occupation.

Included in the Appendix of this study are listings citing the sources of information for the following: length of training and enlisted strength of all military occupations opened to enlisted personnel during a first enlistment period; training curricula, military job descriptions, and task analysis data for each of the 24 military occupations covered in the report; and similar data for civilian occupations used in the analysis.